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TECHNICAL SEMINAR
ON

CLEANING ROBOTS

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Contents

What Is a Cleaning Robots?

- A robotic vacuum is a self-propelled floor cleaner that uses brushes, a rotating brush, or an air-driven turbine to pick up dirt and debris from carpets and hard floors. They work on their own without any human intervention.
- Robo-vacs have sensors to detect obstacles in the way, so that they can navigate around them.
- They are designed for those who want to do less housework but still maintain cleanliness in their homes.
- Runs on electricity or rechargeable batteries.
- Saves time cleaning their homes.

History

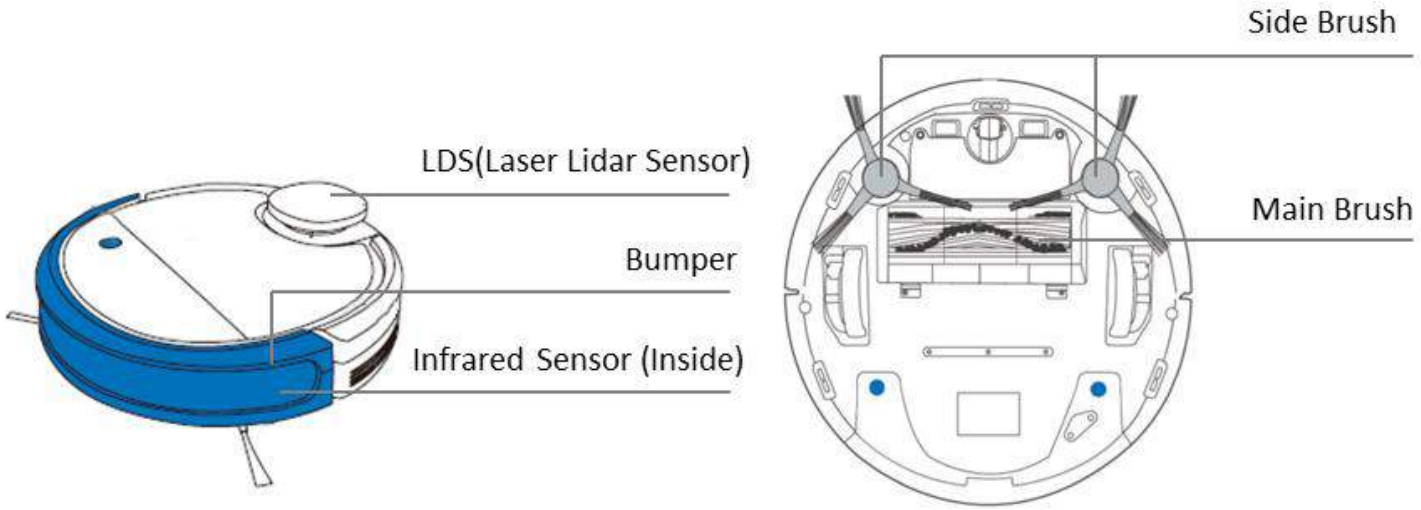
- In 1956, the American science fiction author Robert A. Heinlein described the concept of a robotic vacuum cleaner.
- In 1996, Electrolux introduced the first “Robotic Vacuum Cleaner”, the Electrolux Trilobite. It worked well but had frequent problems. It failed in the market and was discontinued.
- In 2001, Dyson built and demonstrated a robot vacuum known as the DC06. However, due to its high price, it was not released to the market.
- In 2010, the Neato Robotics XV-11 robotic vacuum introduced laser based mapping, allowing navigation in straight lines rather than the traditional random navigation.
- In 2015, Dyson and iRobot both introduced camera based mapping.
- In 2016, iRobot CEO claimed that 20% of vacuum cleaners sales worldwide were robots.
- As of 2018, obstacles such as dog feces, cables and shoes remain very difficult for robots to navigate around.

Self-Cleaning Robot Technology Features

- Vacuum cleaning robots
- Disinfectant-spraying robots
- UV-C robots

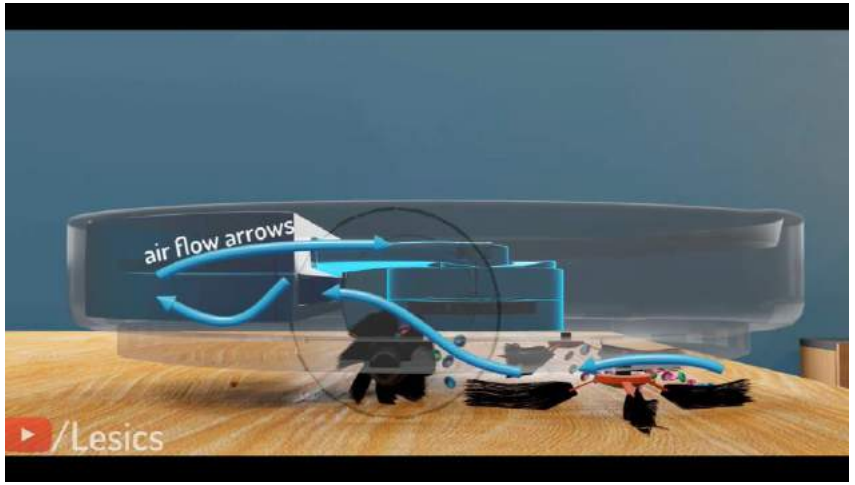
How Does a Cleaning Robot Work?

- Cleaning Robots clean your carpet and floors the same way traditional vacuums do: brushing and sucking up dirt. However, Cleaning Robots can do this without any human intervention through the help of sensors.
- High-end robotic vacuums use infrared lasers to navigate spaces, while cheaper models map the floor using physical boundary stripes. Using either sensor, cleaning robots can detect obstacles, measure the distance they've traveled, detect hazards, and find new areas to clean.

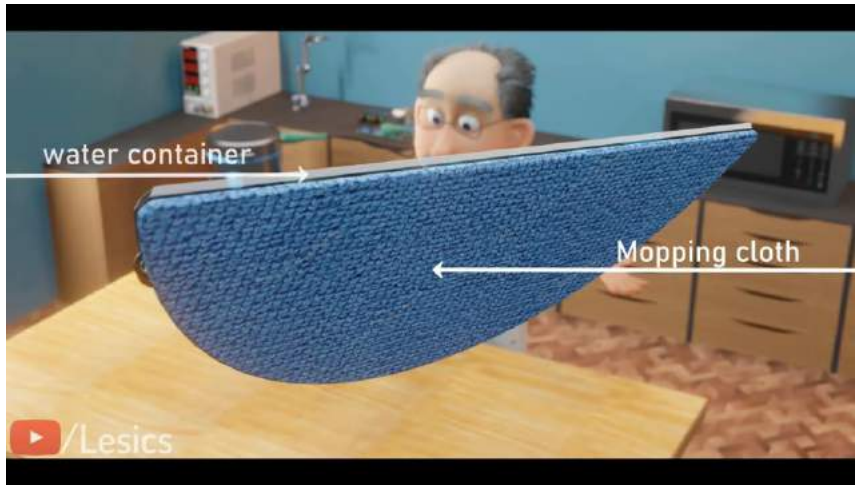


Mechanism of Cleaning Robots

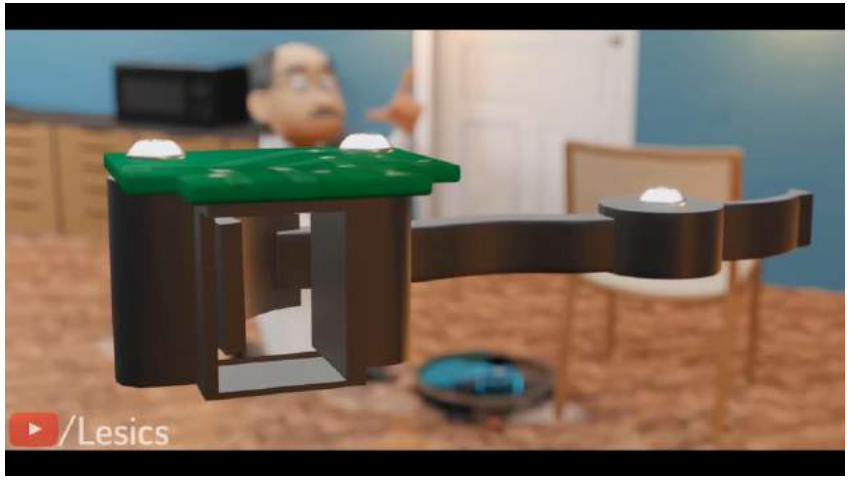
- The basic component required to collect the debris is the vacuum pump.
- The two wheels help the machine move.
- As the opening of this vacuum pump is smaller, an additional set of side brushes is needed to clean efficiently.
- These two side brushes are especially helpful when this machine is cleaning a corner .

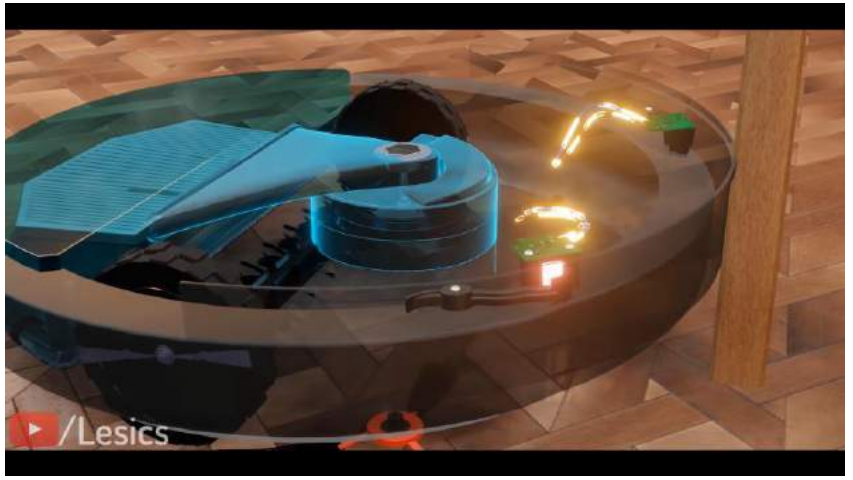


- This arrangement becomes more efficient when we attach a clever mopping attachment.
- This mechanism controls the pressure inside this water chamber and waterflow via the cotton plugs inside.
- This mopping arrangement is capable of removing tough stains.
- Now we need it to be able to detect object and change its trajectory.
- Let's add intelligence to this machine and convert it to a robot.

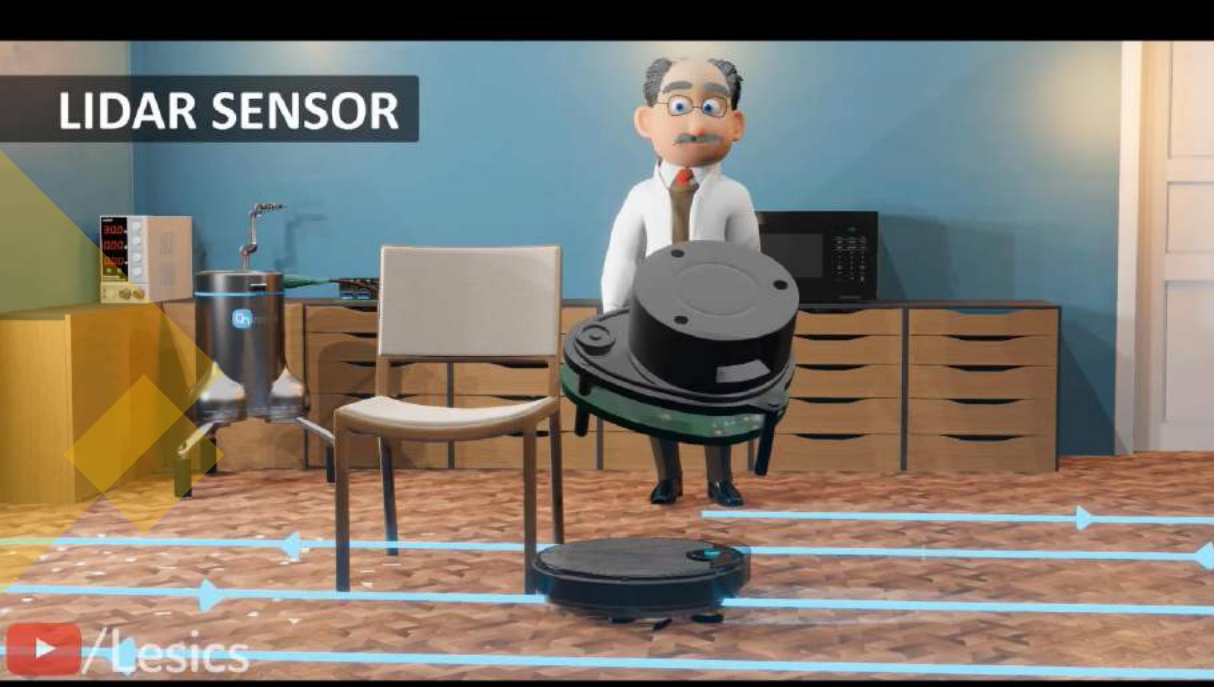


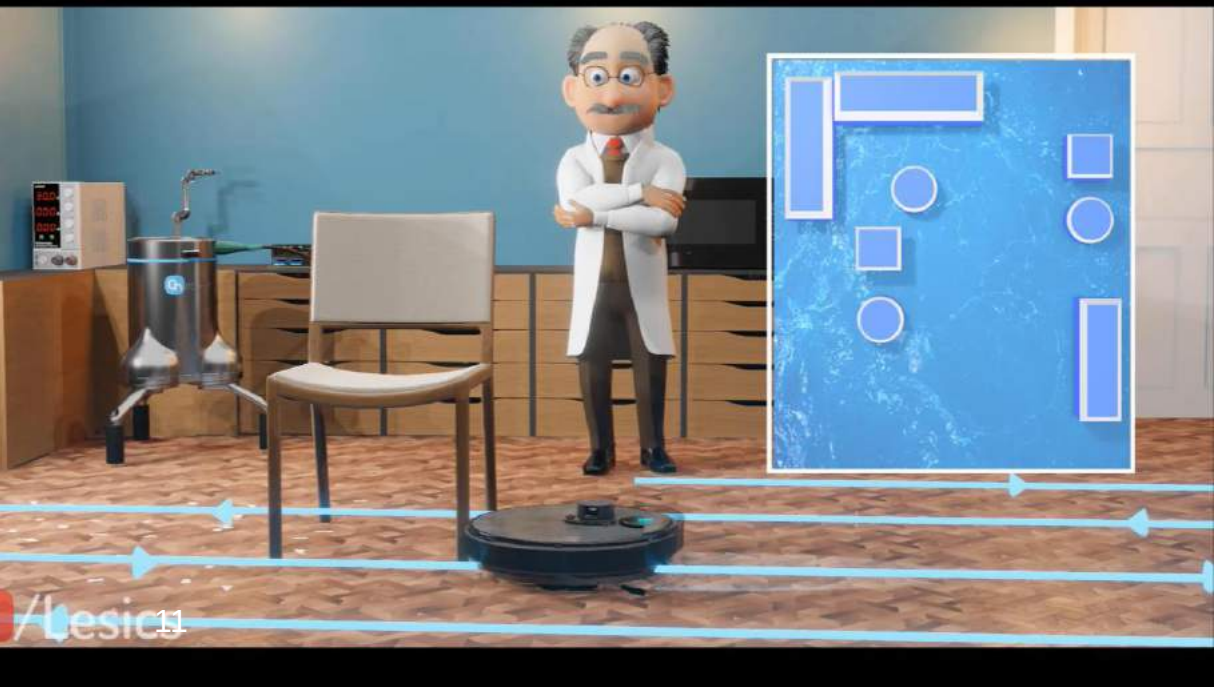
- To solve this issue lets attach the optical limit switches to the front hemisphere of this robot and the bumper to cover the limit switch.
- Now every time the robot hits an object with the help of this bumper gets operated and generates an electronic signal.
- This smart controller process the signal and turns the robot in opposite direction.
- Obviously the robot’s random path doesn’t efficiently cover the entire room. And consumes more power and time.



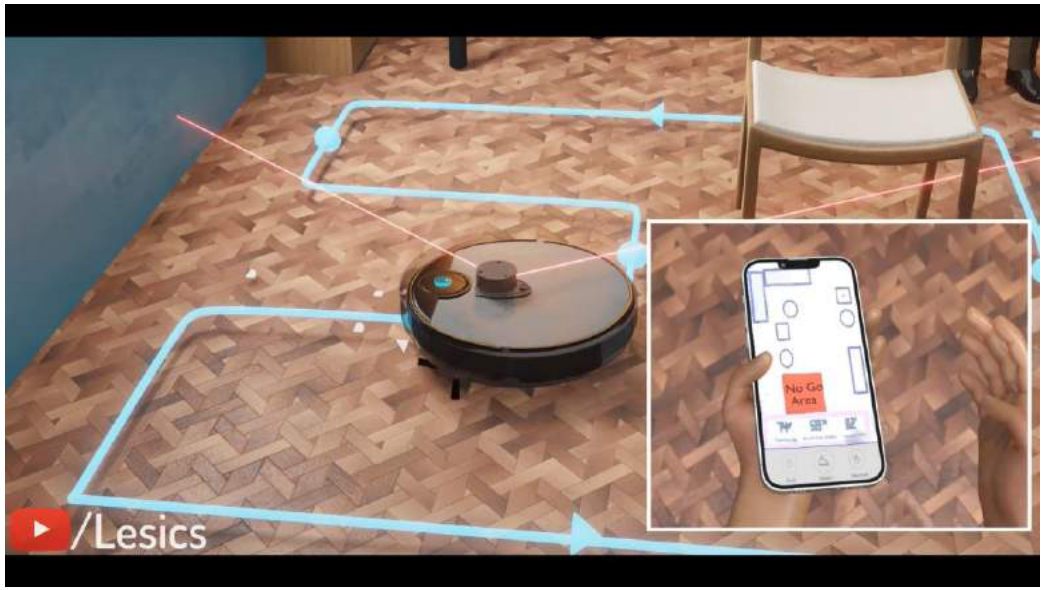


- So robot needs to take proper right angle turns.
- It also has to travel a small distance to avoid overlapping.
- This is done through a gyroscope sensor and wheel encoders to the robot.
- When the robot bumps into this wall the gyroscope sensor will help it to take the angular turns accurately and to cover the proper distance.
- The wheel encoder will come into play by counting the wheels rotation .

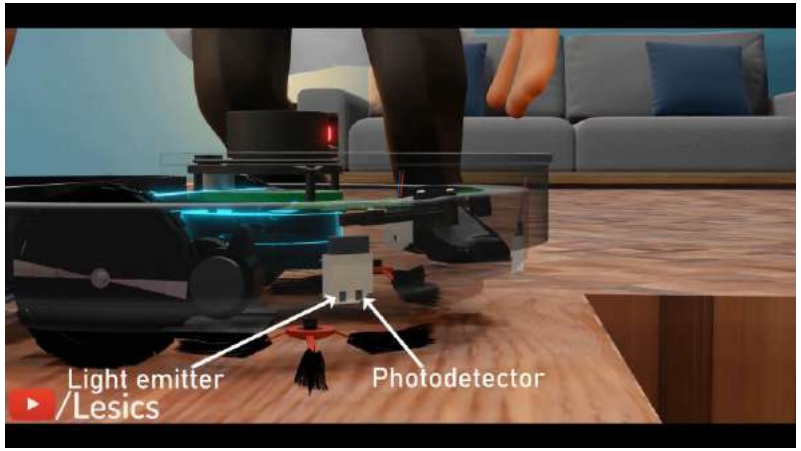


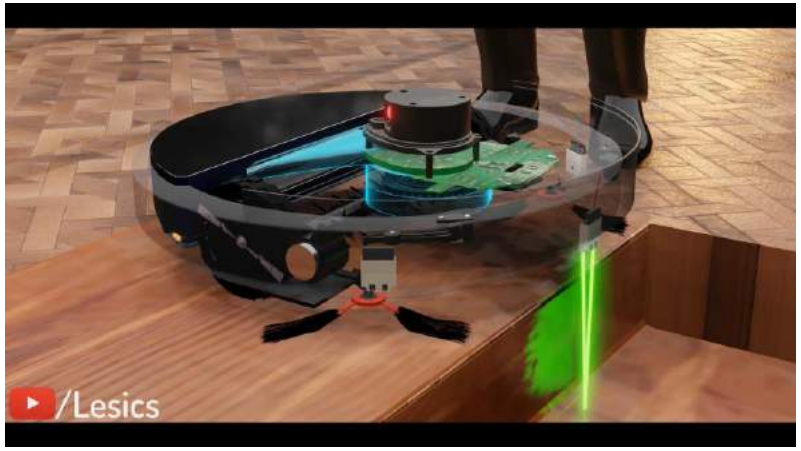


- The robot is unable to differentiate between an object and a wall, this results in area uncleaned.
- Let us add a lidar sensor ,this advanced sensor continuously emits lasers with the help of the return pulse.
- The bot measures the distance between the robot and the objects surrounding while rotating, it creates a 2D map of your room.
- So this robot can now differentiate between the wall and object and follow the efficient cleaning path quite easily.



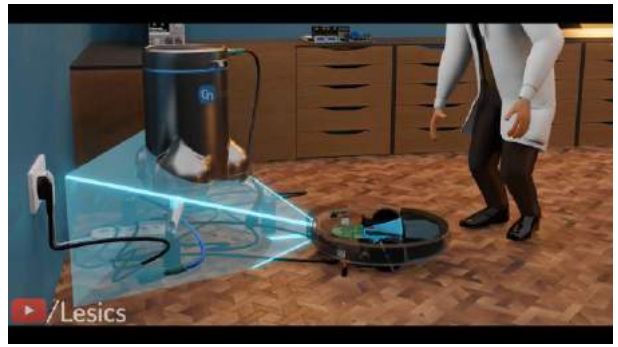
- We can also integrate a handy mobile application for setting up go and no-go zones on the floor cleaning schedule specific area cleaning as well as many more features .
- The robot has problem of climbing more than 2 centimeters high.
- 2 centimeters is the maximum height the robot can climb.
- Staircase cannot be detected even by our 2D lidar sensor.

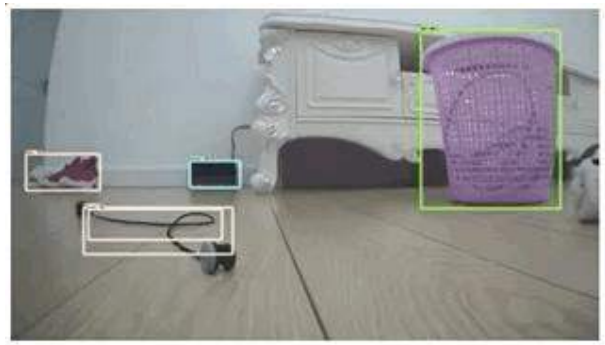




- To avoid this situation we need to place three optical proximity sensors at the edge of the robot.
- This sensor has an IR light emitter and photo detector.
- The generated light from the LED gets reflected back from the surface and is received by this detector.
- The smart controller measures the distance of this reflected light and changes the robots direction by controlling the wheels.

- Still robot is having trouble detecting the electric wire, clothes, toys, pet waste etc. this issue is not discovered by the lidar sensor because it is a 2d detector.
- Let's attach a camera along with an inbuilt 3d depth sensor in front of the robot.
- It maps its front region in 3d and avoids this obstacle, so this sensor is efficient in detecting the obstacles precisely but cannot map the entire room.





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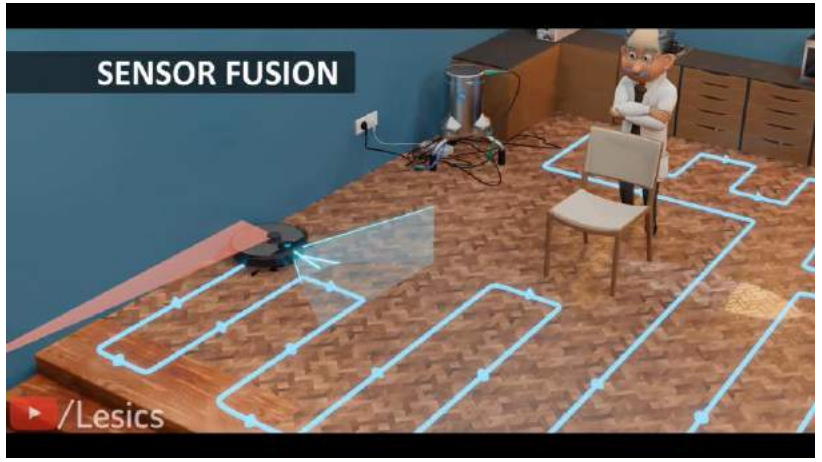
- So introducing sensor fusion technique, using both the lidar and camera system together and combining their data to get more accurate cleaning paths.
- The robot automatically retrace its steps back to its starting point at the charging dock and start recharging the battery.



Advantages

- Wet and Dry Cleaning Function
- No Need for Manual Operation
- They Save Cleaning Time
- Automatically Adjusts to Different Surfaces
- They Can Clean Underneath Furniture
- Adjusts Cleaning Settings
- They Can Be Used for Emergency Cleaning
- Self-Charging

Great Accessibility	**Compact Size and Design**	Can Clean When You Aren't Home
Detects Preset Boundaries	Low Maintenance	Fits Into Tight Spaces
Remote Controlled Cleaning	Larger Dust Bags	Longer Life-Span
Longer Life-Span	No Cords To Deal With	Smart Home Connectivity

Limitations

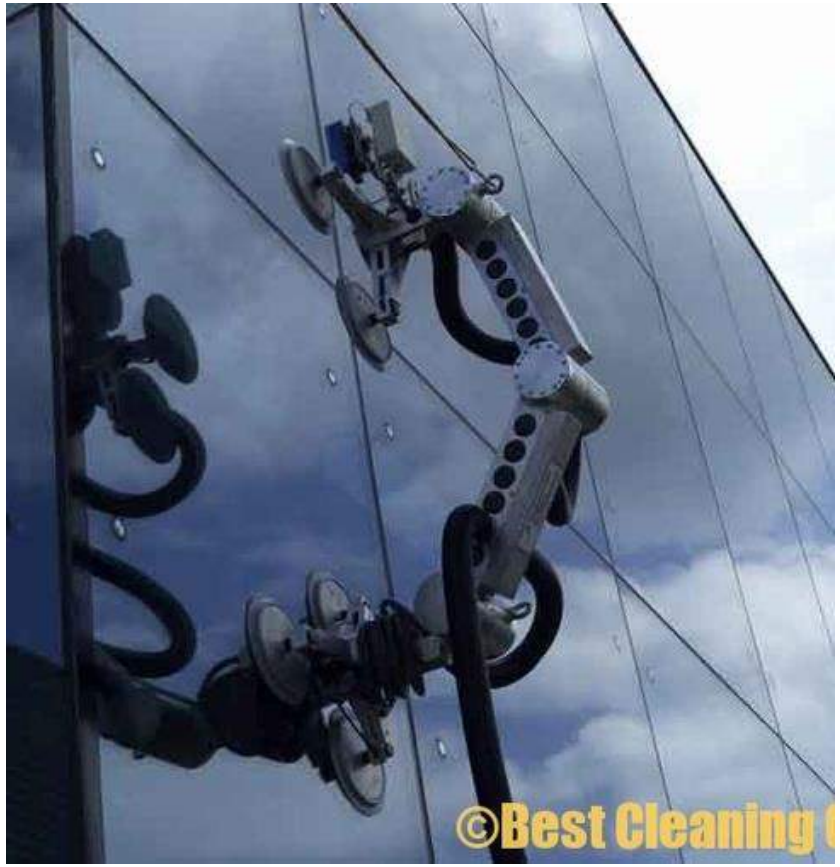
- They’re Not Entirely Hands-off
- Regular maintenance
- They’re Expensive
- They Don’t Work Well on Carpeted Surfaces
- They Don’t Clean as Well as a Traditional Vacuum Cleaner
- They May Dent Furniture

Applications

- Spraying of Disinfectants Robots
- Floor Cleaning Robots
- Bathroom Cleaning Robots
- Pool Cleaning Robots
- Street Cleaning and Garbage Collecting Robots
- Solar Panel Cleaning Robots
- Ships cleaning robots

Future scope

- Covid-19 has positively impacted the robot vacuum industry, resulting in increased demand from residential users.
- The consumer robot market is estimated to grow at a compound annual growth rate (CAGR) of 27 per cent over the next four years, according to Counterpoint's IoT service.
- With advances in AI, the prices of components and software are also coming down, making the robots more affordable.
- It is estimated that the market opportunity of Personal and Education robots will exceed $4.5 billion by 2025.
- In the house cleaning category, the leading players are iRobot, Ecovacs, Roborocks & Mi.
- The consumer service robots market holds tremendous potential in the coming years due to evolving use cases.
- Medical robots still seem a risky proposition as they need a lot of upfront capital expenditure, and the R&D outcomes are unpredictable.



Conclusion

- With technology playing a big part in the cleaning industry, it will help to enhance the productivity of cleaning operations and protect the hygiene level of the environment much more effectively.
- Cleaning robots makes clean and well-maintained spaces in commercial and residential facilities.
- With the use of autonomous robots and innovative cleaning solutions, we can provide a wide range of cleaning in many areas including airport facilities, warehouses and retail spaces.
- This sophisticated cleaning techniques and eco-friendly supplies also extend to residential cleaning services to help maintain clean, healthy homes.

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Thank You